CLAIMS

1. A vehicle mounted imaging system, comprising:

a light source, for providing a pulse like light energy; and

a camera, for receiving said pulse like light energy reflected from objects, said camera enabled to gate detection of said pulse like light energy reflected from objects within a depth of a field to be imaged, said depth of field having a minimal range (R_{min}), said camera starting to detect light energy after a delay timing substantially given by the time it takes said pulse like light energy to reach said minimal range and complete reflecting back to said camera from said minimal range;

said system is characterized in that:

said gate detection is utilized to create a sensitivity as a function of range, such that the received reflection of said pulse like light energy reflected from objects located beyond said minimal range gradually increases with the range along said depth of a field to be imaged.

2. The system according to claim 1, wherein said gate detection is utilized to create said sensitivity as a function of range, such that the received reflection of said pulse like light energy reflected from objects located beyond said minimal range gradually increases with the range along said depth of a field to be imaged until an optimal range (R_o).

3. The system according to claim 2, wherein said gate detection is utilized to create said sensitivity as a function of range, such that the received reflection of said pulse like light energy reflected from objects located beyond said optimal range is maintained detectable until a maximal range (R_{max}).

4. The system according to claim 3, wherein said gate detection is utilized to create said sensitivity as a function of range, such that the received reflection of said pulse like light energy reflected from objects located beyond said optimal range is maintained substantially constant until said maximal range.

5. The system according to claim 3, wherein said gate detection is utilized to create said sensitivity as a function of range, such that the received reflection of said pulse like light energy reflected from objects located beyond said optimal range gradually decreases until said maximal range.

6. The system according to claim 1, wherein

said pulse like light energy defines a substantial pulse width (T_{Laser}), a pulse pattern and a pulse shape;

said gate detection of said pulse like light energy reflected from objects defines a gating time span (T_{II}), during which said camera receives reflections from objects, an OFF time span (T_{off}), during which said camera does not receive reflections from objects and a synchronization timing between said gating time span and the time said pulse like light energy is provided; and

at least one of: said delay timing, said pulse width, said pulse shape, said pulse pattern, said gating time span, said OFF time span, and said synchronization timing, is determined according to at least one of: said depth of a field, specific environmental conditions, a speed of said vehicle and specific characteristics of different targets expected to be found in said depth of field.

7. The system according to claim 6, wherein said determination is dynamic.

8. The system according to claim 6, wherein said determination varies in an increasing or decreasing manner over time.

9. The system according to claim 6, wherein said sensitivity as a function of range comprises a dynamic change of a parameter selected from the group consisting of: said shape of said pulse like light energy, said pattern of said pulse like light energy, said gating time span, said OFF time span, said pulse width, said delay timing, and said synchronization timing.

10. The system according to claim 9, wherein said dynamic change is determined according to at least one of: said depth of field, said specific environmental conditions, said speed of said vehicle, and said characteristics of different targets expected to be found in said depth of field.

11. The system according to claim 9, wherein said pulse width and said gating time span are limited to eliminate or reduce the sensitivity of said system to ambient light sources.

12. The system according to claim 9, wherein

the duration of said pulse width, said OFF time span, and said gating time span defines a cycle time; and

said pulse like light energy is sent for a duration of said pulse width, the opening of said camera is delayed for a duration of said OFF time span, and said pulse like light energy reflected from objects is received for a duration of said gating time span.

13. The system according to claim 12, wherein said pulse width is progressively shortened, and said delay timing is progressively lengthened, while said cycle time is not changed, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

14. The system according to claim 12, wherein said gating time span is progressively shortened said, said delay timing is progressively lengthened, while said cycle time is not changed, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

15. The system according to claim 12, wherein each of said pulse width and said gating time span is progressively shortened, said delay timing is progressively lengthened, while said cycle time is not changed, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

16. The system according to claim 9, wherein said pulse shape comprises an intensity higher at the beginning of said pulse than at the end of said pulse, for increasing said sensitivity as a function of range.

17. The system according to claim 6, wherein

said pulse width commences at a start time (T_0); and

said delay timing is substantially defined in accordance with the following equation:

$$T_{Laser} + \frac{2 \times R_{min}}{c}$$

where c is the speed of light.

18. The system according to claim 6, wherein said pulse width is substantially defined in accordance with the following equation:

$$2 \times \left(\frac{R_o - R_{min}}{c} \right)$$

where R_o is an optimal range and c is the speed of light.

19. The system according to claim 6, wherein said gating time span and said OFF time span are substantially defined in accordance with the following equations

$$T_{II} = 2 \times \left(\frac{R_{max} - R_{min}}{c} \right)$$

$$T_{off} = \frac{2 \times R_{min}}{c}$$

where R_{max} is a maximal range and c is the speed of light.

20. The system according to claim 12, further comprising:

a controller, coupled with said camera and said light source, for determining and changing at least one of: said delay timing, said pulse width, said pulse shape, said pulse pattern, said gating time span, said OFF time span, and said synchronization timing;

at least one ambient light sensor, coupled with said controller;

a pulse detector, coupled with said controller, for detecting pulses emitting from a system similar to said system mounted on an approaching vehicle;

an interface to a computer system of said vehicle, coupled with said controller;

an image-processing unit, coupled with said camera;

a narrow band pass filter, coupled with said camera; and

a display apparatus, coupled with said image-processing unit, for displaying images constructed from said pulse like light energy received in said camera.

21. The system according to claim 20, further comprising:

a light polarizer, coupled with said camera;

a spatial light modulator, coupled with said camera; and

a blinding light source, placed near said light source.

22. The system according to claim 20, wherein at least one repetition of said cycle time forms part of an individual video frame, and a number of said repetitions forms an exposure number per said video frame.

23. The system according to claim 22, wherein said exposure number is varied dynamically.

24. The system according to claim 22, wherein said exposure number is varied according to a level of ambient light determined by said at least one ambient light sensor.

25. The system according to claim 22, wherein said exposure number is varied according to a level of current consumed by said camera.

26. The system according to claim 22, wherein mutual blinding between said system and a similar system passing one another is eliminated by statistical solutions selected from the group consisting of: lowering said exposure number; a change in

said timing of said cycle time during the course of said individual video frame; and a change in the frequency of said exposure number.

27. The system according to claim 22, wherein mutual blinding between said system and a similar system passing one another is eliminated by synchronic solutions selected from the group consisting of:

establishing a communication channel between said system and said similar system;

letting each of said system and said similar system go into listening modes from time to time in which said pulse like light energy is not emitted for a listening period, after said period any of said system and said similar system resume emitting said pulse like light energy if no pulses were collected during said listening period, and after said period said system and said similar system wait until an end of a cyclic sequence of pulse like light energy before resuming emitting said pulse like light energy if pulses were collected during said listening period; and

having said systems change a pulse start transmission time in said individual video frames.

28. The system according to claim 20, wherein said image-processor comprises means for locating areas in said camera in a state of saturation.

29. The system according to claim 22, wherein said image-processor comprises means for processing a variable number of exposures.

30. The system according to claim 6, wherein said camera receives several pulses of said pulse like light energy reflected from objects during said gating time span.

31. The system according to claim 1, wherein said pulse like light energy is non-visible light and said light received in said camera is non-visible light.

32. The system according to claim 6, wherein the intensity of said pulse like energy pulses is adjusted according to said cruising speed of said vehicle, for increasing radiation safety.

33. The system according to claim 32, wherein a divergent cone width of said pulse like light energy propagates at an angle which does not deviate from a width of said vehicle.

34. The system according to claim 1, wherein said light source is selected from the group consisting of: a laser generator, an array of diodes, an array of LEDs, and a visible light source.

35. The system according to claim 1, wherein said camera is selected from the group consisting of CMOS cameras, CCD cameras, a camera having a gated image intensifier and a camera with shutter capabilities.

36. The system according to claim 20, wherein said display apparatus is selected from the group consisting of: a Head Up Display (HUD) apparatus, an LCD display apparatus and a holographic based flat optic apparatus.

37. The system according to claim 21, wherein said spatial light modular is selected from the list consisting of: an area shutter, a liquid crystal and a suspended particle display.

38. An imaging method for a vehicle mounted system, the method comprising the procedures of:

emitting a light pulse to a target area;

receiving at least one image from a reflection of said light pulse reflected from objects within a depth of a field to be imaged, said depth of field having a minimal range (R_{min});

gating detection of images received by a gated camera, wherein the gating starts to detect said light pulse after a delay timing of the gating with respect to

said reflection of said light pulse substantially given by the time it takes said light pulse to reach said minimal range and complete reflecting back to said camera from said minimal range; and

intensifying said images received,

said method is characterized in that:

said gating is utilized to create a sensitivity as a function of range, such that received light energy of said reflection of said light pulse reflected from objects located beyond said minimal range gradually increases with the range along said depth of a field to be imaged.

39. The method according to claim 38, wherein said gating is utilized to create said sensitivity as a function of range, such that received light energy of said reflection of said light pulse reflected from objects located beyond said minimal range gradually increases with the range along said depth of a field to be imaged until an optimal range (R_o).

40. The method according to claim 39, wherein said gating is utilized to create said sensitivity as a function of range, such that received light energy of said reflection of said light pulse reflected from objects located beyond said optimal range is maintained detectable until a maximal range (R_{max}).

41. The method according to claim 40, wherein said gating is utilized to create said sensitivity as a function of range, such that received light energy of said reflection of said light pulse reflected from objects located beyond said optimal range is maintained substantially constant until said maximal range.

42. The method according to claim 40, wherein said gating is utilized to create said sensitivity as a function of range, such that received light energy of said reflection of said light pulse reflected from objects located beyond said optimal range gradually decreases until said maximal range.

43. The method according to claim 38, wherein

said light pulse defines a substantial pulse width (T_{Laser}), a pulse pattern, and a pulse shape;

said procedure of gating comprises a gating time span (T_{II}), an OFF time span (T_{off}), and a synchronization timing of said gating with respect to said emitting; and

said method further comprises the procedure of determining at least one of: said delay timing, said pulse width, said pulse shape, said pulse pattern, said gating time span, said OFF time span, and said synchronization timing according to at least one of: said depth of a field, specific environmental conditions, a speed of said vehicle, and specific characteristics of different targets expected to be found in said depth of field.

44. The method according to claim 43, wherein said procedure of determining is dynamic.

45. The method according to claim 43, wherein said procedure of determining according to said depth of a field comprises varying said sensitivity in an increasing or decreasing manner over time.

46. The method according to claim 38, wherein said sensitivity as a function of range comprises the procedure of dynamically changing at least one parameter selected from the group consisting of: said pattern of said light pulse, said shape of said light pulse, said gating time span, said OFF time span,said pulse width, said delay timing, and said synchronization timing.

47. The method according to claim 46, wherein said procedure of dynamically changing comprises changing according to at least one of: said depth of field, specific environmental conditions, a speed of said vehicle and characteristics of different targets expected to be found in said depth of field.

48. The method according to claim 46, wherein said pulse width and said gating time span are limited to eliminate or reduce said sensitivity to ambient light sources.

49. The method according to claim 46, wherein said procedure of changing comprises the sub-procedures of sending said light pulse for a duration of said pulse width, delaying the opening of said camera for a duration of said OFF time span, and receiving light pulse energy reflected from objects for a duration of said gating time span, and wherein said pulse width, said OFF time span and said gating time span define a cycle time.

50. The method according to claim 49, wherein said procedure of changing comprises shortening said pulse width progressively and lengthening said delay timing progressively, while retaining a cycle time of said gating unchanged, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

51. The method according to claim 49, wherein said procedure of changing comprises shortening said gating time span progressively and lengthening said delay timing progressively, while retaining a cycle time of said gating unchanged, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

52. The method according to claim 49, wherein said procedure of changing comprises shortening said pulse width and said gating time span progressively, lengthening said delay timing progressively, while retaining a cycle time of said gating unchanged, for increasing said sensitivity as a function of range when accumulating reflections of pulses for an individual frame.

53. The method according to claim 46, wherein said pulse shape comprises an intensity higher at the beginning of said pulse than at the end of said pulse, for increasing said sensitivity as a function of range.

54. The method according to claim 43, wherein said procedure of emitting said light pulse commences at a start time (T_0); and

said delay timing is substantially calculated in accordance with the following equation:

$$T_{Laser} + \frac{2 \times R_{min}}{c}$$

where c is the speed of light.

55. The method according to claim 43, wherein said pulse width is substantially calculated in accordance with the following equation:

$$2 \times \left(\frac{R_o - R_{min}}{c} \right)$$

where R_o is an optimal range and c is the speed of light.

56. The method according to claim 43, further comprising the procedure of controlling said gating time span and said OFF time span, substantially in accordance with the following equations:

$$T_{II} = 2 \times \left(\frac{R_{max} - R_{min}}{c} \right)$$

$$T_{off} = \frac{2 \times R_{min}}{c}$$

where R_{max} is a maximal range and c is the speed of light.

57. The method according to claim 49, wherein at least one repetition of said cycle time forms part of an individual video frame, and a number of said repetitions form an exposure number for said video frame.

58. The method according to claim 57, further comprising the procedure of dynamically varying said exposure number.

59. The method according to claim 58, wherein said procedure of varying comprises adjusting said exposure number according to a level of detected ambient light.

60. The method according to claim 58, wherein said procedure of varying comprises adjusting said exposure number according to a level of current consumed by an image intensifier utilized for said procedure of intensifying.

61. The method according to claim 57, further comprising the procedure of eliminating mutual blinding between said system and a similar system passing one another by statistical solutions selected from the group consisting of: lowering said exposure number; a change in said timing of said cycle time during the course of said individual video frame; and a change in frequency of said exposure number.

62. The method according to claim 57, further comprising the procedure of eliminating mutual blinding between said system and a similar system passing one another by synchronic solutions selected from the group consisting of:

establishing a communication channel between said system and said similar system;

letting each of said system and said similar system go into listening modes from time to time in which said light pulse is not emitted for a listening period, after which period any of said system and said similar system resume emitting said light pulse if no pulses were collected during said listening period, and after which period said system and said similar system wait until an end of a cyclic sequence of said light pulses before resuming emitting said light pulse if pulses were collected during said listening period; and

having said systems change a pulse start transmission time in said individual video frames.

63. The method according to claim 57, further comprising the procedure of image processing by locating areas in said camera in a state of saturation.

64. The method according to claim 57, further comprising the procedure of image processing for a variable number of exposures.

65. The method according to claim 64, wherein said procedure of image processing

comprises the procedures of:

taking at least two video frames, one with a high exposure number, the other with a low exposure number, by image processing of a variable number of exposures;

determining exposure numbers for said at least two video frames; and

combining frames to form a single video frame by combining dark areas from frames with a high exposure number and saturated areas from frames with a low exposure number.

66. The method according to claim 43, further comprising the procedure of receiving several pulses of said light pulse reflected from objects during said gating time span.

67. The method according to claim 38, wherein said procedure of emitting light pulses comprises emitting non-visible light and said procedure of receiving at least one image by said gated camera comprises receiving non-visible light in said gated camera.

68. The method according to claim 43, further comprising the procedure of adjusting the intensity of said light pulse according to a cruising speed of said vehicle, for controlling radiation safety.

69. The method according to claim 68, further comprising the procedure of propagating a divergent cone width of said light pulse at an angle which does not deviate from a width of said vehicle.

70. The method according to claim 69, further comprising the procedure of placing a blinding light source near said light source.

71. The method according to claim 38, further comprising the procedure of displaying said at least one image on a display apparatus for displaying images constructed from said light pulse received in said camera.

72. The method according to claim 38, further comprising the procedure of determining ambient light in said target area.

73. The method according to claim 38, further comprising the procedure of determining if other light pulses are present in said target area.

74. The method according to claim 38, further comprising the procedure of filtering received wavelengths of received reflections using a narrow band pass filter.

75. The method according to claim 38, further comprising the procedure of overcoming glare from other light pulses by locally darkening the entrance of an image intensifier utilized for said intensifying.

76. The method according to claim 38, comprising the procedure of overcoming glare from other light pulses by polarizing light entering an image intensifier utilized for said intensifying.